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PENSOFT

First southeastern Pacific record of Balloon Alfonsin, *Beryx mollis* Abe, 1959 (Beryciformes, Berycidae), with notes on geographical meristic variations

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Abstract. Four specimens (151–156 mm in standard length) of *Beryx mollis* Abe, 1959 were collected from the Nazca Ridge, southeastern Pacific Ocean. These specimens represent the first record of the species from the southeastern Pacific Ocean and extend the distributional range of the species eastward by ca. 10,000 km from New Caledonia, the previously known eastern limit. Comparison with specimens from other regions reveals geographical variations of some meristic characters in the species.

Keywords. *Beryx splendens*, deep-sea, distribution, Nazca Ridge, range extension, Teleostei

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Introduction

The original description of the Balloon Alfonsin, *Beryx mollis* Abe, 1959 (Beryciformes, Berycidae), was based on three specimens collected from the Sagami Bay, Japan (Abe 1959). Although *B. mollis* had been treated as a junior synonym of *Beryx splendens* Lowe, 1834 in several earlier studies (e.g. Woods and Sonoda 1973; Heemstra 1986) due to their morphological similarity, Yoshino et al. (1999) examined type specimens of *B. mollis* and confirmed that it is clearly distinguishable from *B. splendens* based on multiple morphological characters. Subsequently, significant genetic differences based on the mitochondrial 16S rRNA (Akimoto et al. 2002) and cytochrome b genes (Akimoto et al. 2006) were found to exist between the two species. To date, *B. mollis* has been reported from the Indo-West Pacific based on morphological examinations of specimens (e.g. Yoshino and Kotlyar 2001; Borsa et al. 2011) and molecular investigations (e.g. Akimoto et al. 2006; Yanagimoto and Kobayashi 2012).

Four specimens of *B. mollis* were discovered among berycid specimens collected from the Nazca Ridge in 1999. As these specimens represent the first southeastern Pacific record of the species and greatly extend its geographical range, the morphology of the specimens is described herein. In addition, geographical variations of several morphological characters in the species are presented.

Methods

Methods for counts and measurements followed Yoshino et al. (1999). Standard length is abbreviated as SL. All measurements were made with a calipers to the nearest 0.1 mm, except for SL, which is measured to the nearest 1 mm. Pectoral and pelvic-fin rays were counted on both sides. Gill rakers were counted on the first gill arch of the right side. A distribution map was generated using R v. 4.0.5 (R Core Team 2021) with bathymetric data by ETOPO1 (Amante and Eakins 2009). Comparative specimens from Indonesia were collected in the Japan–Indonesia Deep Sea Fisheries Resources Joint Exploration Project conducted by OFCF (Overseas Fishery Cooperation Foundation of Japan) and the Agency for Marine and Fisheries Research, Ministry of Marine Affairs and Fisheries of the Government of Indonesia during 2004 and 2005. Specimens examined

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in this study are deposited at the Hokkaido University Museum, Hakodate, Japan (HUMZ).

Comparative materials. *Beryx mollis* (11 specimens, 104–263 mm SL): HUMZ 190778, 104 mm SL, off Sumatra (05°29.11′N, 094°01.47′E–05°27.49′N, 094°01.52′E), 347–361 m depth, 13 Oct. 2004; HUMZ 190857, 174 mm SL, off Sumatra (04°24.43′S, 101°04.35′E–04°24.3′S, 101°03.3′E), 396–453 m depth, 27 Sep. 2004; HUMZ 190917, 161 mm SL, off Sumatra (05°20.33′N, 094°06.12′E–05°20.16′N, 094°04.44′E), 476–495 m depth, 20 Oct. 2004; HUMZ 191116, 191117, 160–183 mm SL, off Sumatra (03°42.15′N, 094°44.55′E–03°43.31′N, 094°44.33′E), 833–896 m depth, 21 Oct. 2004; HUMZ 193726, 193727, 119–139 mm SL, off Java (08°11.6′S, 108°50.4′E–08°10.7′S, 108°49.1′E), 363–380 m depth, 6 May 2005; HUMZ 193932, 193933, 107–112 mm SL, off Java (08°18.8′S, 109°49′E–08°19.6′S, 109°47.9′E), 305–330 m depth, 10 May 2005; HUMZ 193935, 193936, 237–263 mm SL, off Sumatra (02°51.8′N, 095°05.53′E–02°50.9′N, 095°04.3′E), 519–581m depth, 13 June 2005.

Results

***Beryx mollis* Abe, 1959**
(English name: Balloon Alfonsin; Japanese name: Fusen-kinme)

Figure 1; Tables 1, 2

New records. SE PACIFIC OCEAN – **High seas** • Nazca Ridge; 25°28′S, 084°12′W; 290 m depth; 24.X.1999; R/V *Shinkai-Maru*; bottom trawl; 4 specimens, 151–156 mm SL, HUMZ 164752–164755.

Identification. The genus *Beryx* Cuvier, 1829 comprises three valid species (Busakhin 1982): *Beryx decadactylus* Cuvier, 1829, *B. mollis*, and *B. splendens*. The following characteristics of the present specimens agree well with those of *B. mollis* and differ from *B. splendens* as presented by Yoshino et al. (1999): 13 dorsal-fin soft rays [12–13 (mode 13) in *B. mollis* vs. 13–15 (mode 14) in *B. splendens*], 15–18 pyloric caeca (15–20 in *B. mollis* vs. more than 27 in *B. splendens*) and oval posterior nostril (oval in *B. mollis* vs. slit-like in *B. splendens*). The specimens are also clearly distinguishable from *B. decadactylus* in having 13 dorsal-fin soft rays and 15–18 pyloric caeca (16–20 and more than 70, respectively, in *B. decadactylus*) (Busakhin 1982; Yoshino et al. 1999).

Description. Proportional measurements and counts are provided in Table 1. Body oblong and compressed, depth greatest at origin of dorsal fin (Fig. 1). Mouth large and oblique. Posterior margin of upper jaw extending slightly beyond vertical through middle of orbit but not posterior margin. Small conical teeth arranged in bands on jaws and palatine, and in a small patch on vomer. Anterior and posterior nostrils oval. Posterolaterally directed spine on lachrymal with a small, supplemental spine at its base. Eye large, diameter 2.2–2.3 in head length. Posterior margin of preopercle and interopercle, and bony ridges on head finely serrated. Most of body covered with ctenoid scales; posterodorsal portion of pectoral-fin base covered with cycloid scales. Cheek and opercle covered with ctenoid scales. Lateral line on trunk running along dorsal profile of body and extending onto caudal fin. Dorsal fin located on middle of body; dorsal-fin base much shorter than anal-fin base. Anal-fin origin slightly anterior to vertical through posterior end of dorsal-fin base. Pectoral fin positioned anterior to vertical through dorsal-fin origin; tip of pectoral fin reaching to vertical through posterior end of dorsal-fin base. Pelvic-fin origin below posterior end of pectoral-fin base; tip of pelvic fin reaching to bases of second to fourth anal-fin soft rays. In preservative, coloration of body and head almost uniformly brownish. Oral and branchial cavities pale yellow. Peritoneum black.

Distribution. Southern Japan, Taiwan, South China Sea off Vietnam, West Mariana Ridge, New Caledonia, eastern Indian Ocean off Indonesia, southeastern Indian Ocean near the Broken Ridge, northwestern Indian Ocean (e.g. Kotlyar 1993, 1996; Yoshino and Kotlyar 2001; Akimoto et al. 2006; Borsa et al. 2011; Fricke et

Figure 1. Preserved specimen of *Beryx mollis*. HUMZ 164752, 151 mm SL, Nazca Ridge, southeastern Pacific Ocean. Scale bar = 50 mm.

Table 1. Comparison of proportional measurements and counts for specimens of *Beryx mollis*. Numbers in parentheses indicate specimens examined.

	Present study		Yoshino and Kotlyar 2001	Yoshino et al. 1999
	Nazca Ridge, SE Pacific *n* = 4	**Off Indonesia, E Indian Ocean *n* = 11**	**Error Seamount, W Indian Ocean *n* = 67**	**S Japan, W Pacific *n* = 21**
SL (mm)	151–156	104–263	124–243	114.3–308.9
Measurements (% SL)				
Body depth	38.3–41.0	38.4–43.4	34.6–41.8	39.0–43.2
Head length	34.2–35.8	32.7–39.3	32.8–38.0	31.8–39.3
Snout length	6.0–6.9	6.2–7.7	—	6.5–9.5
Upper-jaw length	16.5–17.7	17.3–20.1	16.9–20.7	17.1–19.5
Eye diameter	15.1–15.8	14.5–17.5	12.6–17.3	13.8–15.9 (20)
Interorbital width	7.2–7.5 (3)	6.9–7.9	5.1–8.5	6.8–8.4 (20)
Suborbital width	1.5–1.7	1.7–2.0	—	1.0–2.1
Caudal-peduncle depth	9.7–10.5	9.4–11.0	8.2–11.0	6.7–10.4
Caudal-peduncle length	11.8–12.6	11.3–13.9	10.9–15.2	11.1–14.3
Pectoral-fin length	29.5–30.2	28.6–31.5 (10)	23.3–30.0	25.1–31.8
Pelvic-fin length	25.6–28.5	23.9–27.3 (10)	19.4–27.8	24.1–33.2
Counts				
Dorsal-fin rays	IV, 13	IV, 12–14	IV, 12–13	IV, 12–13
Anal-fin rays	IV, 28–30	IV, 25–30	IV–V, 24–28	IV, 27–32
Pectoral-fin rays	16–17	15–16	15–17	16–18
Pelvic-fin rays	I, 10–11	I, 9–10	I, 10–11	I, 9–10
Lateral-line scales	67–71	58–65	64–79	60–69
Gill rakers	7 + 19 = 26	5–7 + 17–19 = 22–25	6–7 + 16–20	6–7 + 14–17
Pyloric caeca	15–18	15–20	12–20 (38)	15–20

al. 2011; Yanagimoto and Kobayashi 2012; Koeda 2020; Yanagimoto and Chow 2020) and Nazca Ridge (present study) (Fig. 2).

Discussion

In the Pacific Ocean, the eastern distributional limit of *Beryx mollis* had been previously known to be New Caledonia (Akimoto et al. 2006; Borsa et al. 2011; Fricke et al. 2011). The present specimens from the Nazca Ridge, therefore represent the first southeastern Pacific record of the species and greatly extend the distributional range of this species eastward from New Caledonia by ca. 10,000 km. The present record implies that *B. mollis* may be distributed widely in the South Pacific Ocean.

Yoshino and Kotlyar (2001) identified morphological variations between specimens of *B. mollis* from southern Japan and others from the Error Seamount, northwestern Indian Ocean, in numbers of anal-fin soft rays and lower gill rakers, body depth, and pelvic-fin length. To further clarify geographical variations of the species with these and other regions, 11 specimens collected from the eastern Indian Ocean off Indonesia and the current Nazca Ridge specimens were examined and compared with the specimens from southern Japan and the northwestern Indian Ocean as presented by Yoshino et al. (1999), Yoshino and Kotlyar (2001), and Kotlyar (1993) (Tables 1, 2). Although no clear differences were found in proportional measurements, distinct geographical variations were found with some meristic characters (Table 2). While the number of dorsal-fin soft rays in specimens in the four localities is almost the same, the number of anal-fin soft rays of northwestern Indian specimens appears to be lesser than in specimens from other regions. Regarding numbers of pectoral and pelvic-fin soft rays, Nazca Ridge specimens appear to have more than in specimens from other regions, although counts from that region are scarce. The number of lateral line scales of Indonesian and southern Japan specimens is lower than in specimens from other regions. Different tendencies were found for the number of lower gill rakers in the four regions, progressively increasing in number geographically in specimens from southern Japan, Indonesia, northwestern Indian Ocean and Nazca Ridge. The number of pyloric caeca of northwestern Indian specimens is slightly lower than specimens from other regions. Although the morphology of southwestern Pacific (New Caledonia) specimens was not examined in the present study, the analysis of cytochrome b genes by Akimoto et al. (2006) demonstrated that the most frequent haplotypes in Japanese and New Caledonian specimens of *B. mollis* were

Table 2. Frequency distributions for meristic characters of *Beryx mollis* specimens from four geographical regions.

	Dorsal-fin soft rays			Anal-fin soft rays									Pectoral-fin rays			Pelvic-fin rays		
	12	13	14	24	25	26	27	28	29	30	31	32	15	16	17	9	10	11
Nazca Ridge		4						1	1	2				3	5		1	7
Off Indonesia	1	9	1		1		4	3	2	1			10	12		4	18	
Northwestern Indian Ocean*	12	53	8	3	24	23	16	7					19	50	4	1	60	12
Southern Japan†	3	18					2	4	7	5	2	1	5	13	3	3	18	

	Lateral-line scales																			
	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Nazca Ridge										1	2			1						
Off Indonesia	1			2	2	1	2	3												
Northwestern Indian Ocean*							4		4	6	10	11	9	7	6	5	4	4	2	1
Southern Japan†			2		3	5	3	2	4		1	1								

	Lower gill rakers						
	14	15	16	17	18	19	20
Nazca Ridge						4	
Off Indonesia				6	4	1	
Northwestern Indian Ocean *			1	12	40	19	1
Southern Japan†	3		14	4			

	Pyloric caeca								
	12	13	14	15	16	17	18	19	20
Nazca Ridge				1	1	1	1		
Off Indonesia				1	2	3	2	2	1
Northwestern Indian Ocean *	2	7	4	11	9	3	3		1
Southern Japan†				1	3	5	3	2	

*Data from Kotlyar (1993), including two specimens collected from South China Sea.
†Data from Yoshino et al. (1999).

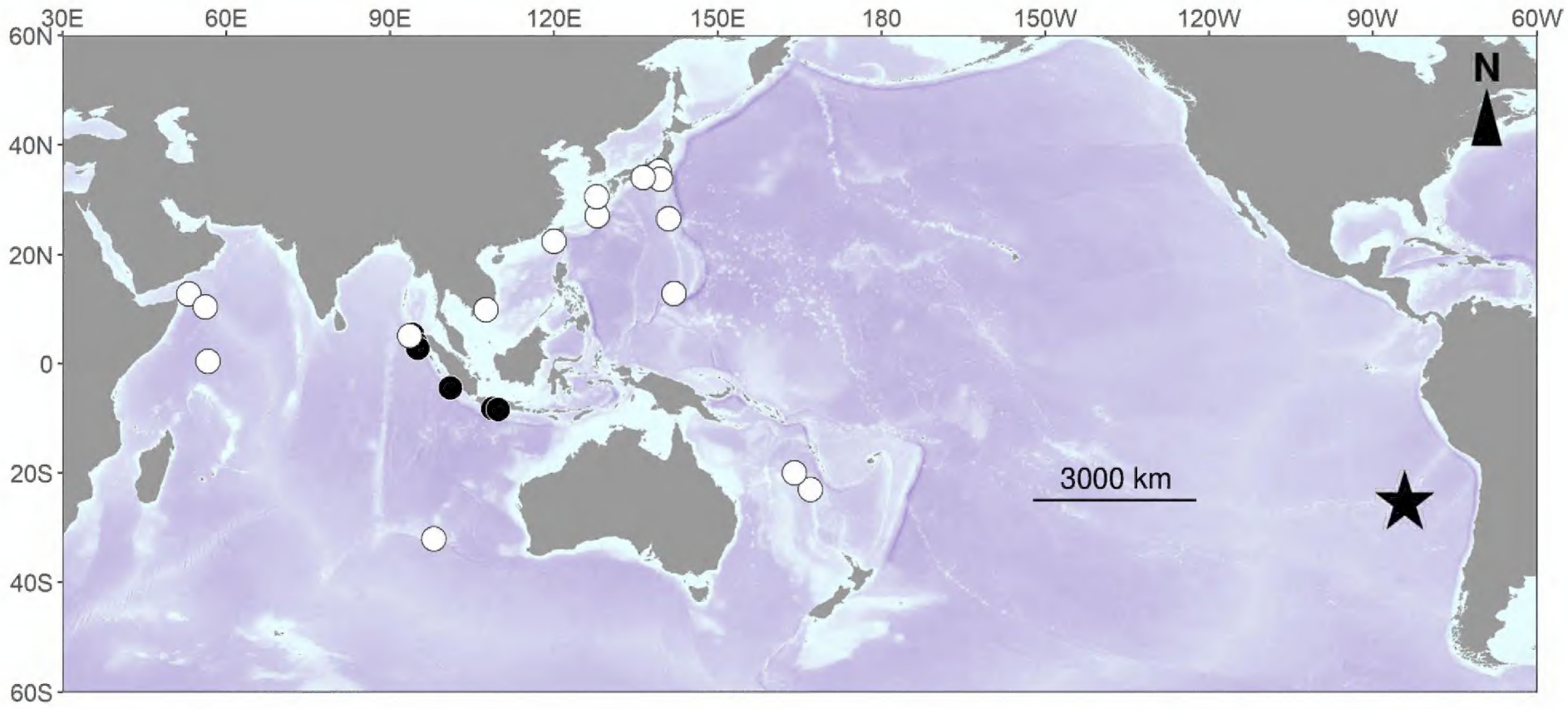

Figure 2. Map showing collection localities for specimens of *Beryx mollis* reported. Star: new record; black spots: specimens examined in present study; white spots: specimens reported in previous studies. Scale indicates distance at 25° latitude.

identical, which suggests gene flow at the trans-oceanic scale for the species collected from Japan and New Caledonia. Both morphological and molecular investigations with sampling from more regions will clarify if there are geographic isolations in Indo-Pacific populations of the species.

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